

The DIRECT project: Catalogs of stellar objects in nearby galaxies. II. Eastern arm and NGC 206 in M31.*

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Abstract. DIRECT is a project to directly obtain the distances to two important galaxies in the cosmological distance ladder, M31 and M33, using detached eclipsing binaries and Cepheids. As part of our search for these variables, we have obtained photometry and positions for thousands of stellar objects within the monitored fields, covering an area of 557.8 arcmin². In this research note we present the equatorial coordinates and *BVI* photometry for 26 712 stars in the M31 galaxy, along the eastern arm and in the vicinity of the star forming region NGC206.

Key words. galaxies: individual (M31) – galaxies: stellar content

1. Introduction

Starting in 1996 we undertook a long term project, DIRECT, to obtain the distances to two important galaxies in the cosmological distance ladder, M31 and M33. These “direct” distances will be obtained by determining the distance of Cepheids using the Baade-Wesselink method and by measuring the distance to detached eclipsing binaries (DEBs).

As the first step of the DIRECT project we have searched for DEBs and new Cepheids in M31 and M33. In the M31 galaxy we have analyzed five 11' × 11' fields, A–D and F (Kaluzny et al. 1998, 1999; Mochejska et al. 1999; Stanek et al. 1998, 1999; hereafter Papers I, IV, V, II, III). A total of 410 variables, mostly new, were found: 48 eclipsing binaries, 206 Cepheids and 156 other periodic, possible long-period or non-periodic variables. In the first paper of the series of stellar catalogs we have presented the catalog of stars in the central part of M33 (Macri et al. 2001). In this research note we present the equatorial coordinates and *BVI* photometry for 26 712 stars detected in the M31 galaxy within the monitored area of 557.8 arcmin².

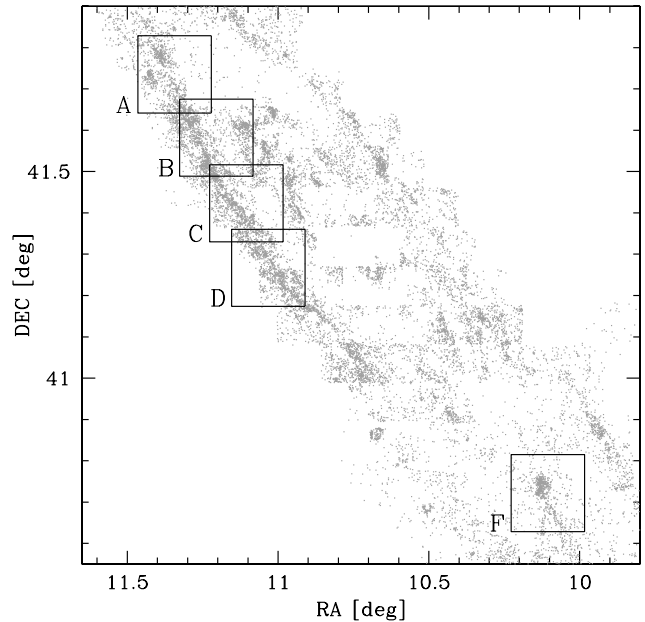


Fig. 1. Location of the fields A–D and F observed in M31.

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* Tables 1–5 are only available in electronic form at the CDS via anonymous ftp to cdsarc.u-strbsg.fr (130.79.125.5) or via <http://cdsweb.u-strbsg.fr/Abstract.html>. They are also available through anonymous ftp on cfa-ftp.harvard.edu, in pub/kstanek/DIRECT directory.

2. Observations and data reduction

We have observed five fields, A–D, concentrated on the rich spiral arm, and F, containing the giant star formation region known as NGC 206 (Fig. 1). The center (α_{2000} , δ_{2000}) coordinates of the fields were: A (11^h34, 41^m73);

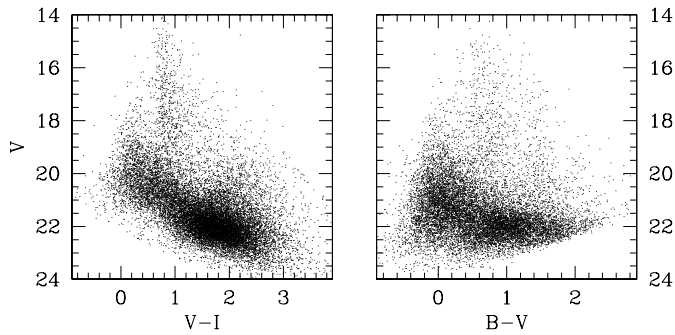


Fig. 2. $V/V-I$ and $V/B-V$ color magnitude diagrams.

B ($11^{\circ}20$, $41^{\circ}59$); C ($11^{\circ}10$, $41^{\circ}42$); D ($11^{\circ}03$, $41^{\circ}27$); F ($10^{\circ}10$, $40^{\circ}72$);

M31 was primarily observed in 1996 with the 1.3 m McGraw-Hill Telescope at the Michigan-Dartmouth-MIT (MDM) Observatory. We used the front-illuminated, Loral 2048² CCD “Wilbur” (Metzger, Tonry & Luppino 1993). Data for M31 were also obtained, mostly in 1997, with the 1.2 m telescope at the F. L. Whipple Observatory (FLWO), where we used “AndyCam” (Szentgyorgyi et al. 1999), with a thinned, back-illuminated, AR coated Loral 2048² pixel CCD. The pixel scale was essentially the same at both telescopes, 0.32 arcsec pixel⁻¹, giving a field of view of roughly 11×11 arcmin².

For the full description of the applied data reduction, calibration and astrometry procedures the reader is referred to Paper I. Here we present only a very brief summary. Stellar profile photometry was extracted using the Daophot/Allstar package (Stetson 1987). The transformation of instrumental magnitudes to the standard system was based on 18 standard stars (Landolt 1992) observed on the night of 1996 September 14/15 at MDM. The residuals in V , $V-I$ and $B-V$ showed no overall offsets and no dependence on color (Fig. 2 in Paper I). A comparison with the Magnier et al. (1992) photometry showed very good agreement in V (average $V - V_{Ma92} = 0.013$ for stars with $V < 20$) and a strong trend in $V-I$ residuals with the $V-I$ color (Fig. 4 in Paper I). We have obtained independent calibrations at MDM on the night of 1996 October 2/3 with the Charlotte 1024² CCD (field B) and at FLWO on the night of 1997 October 9/10 (fields C, D, F). The offsets in V and $V-I$, respectively, were 0.040 and 0.016 in field B, 0.012 and 0.024 in field C, -0.014 and 0.047 in field D, -0.020 and 0.057 in field F. Apart from the offsets, we did not see anything resembling the strong trend in the $V-I$ residuals, seen in the comparison with the photometry of Magnier et al. (1992). This discrepancy certainly deserves further attention. To check the internal consistency of our calibration, we have compared the photometry in the overlapping regions between the fields. The offsets in V and I , respectively, were 0.022 and 0.018 between fields A and B, 0.034 and 0.024 between B and C, and -0.063 and -0.040 between C and D. The offset in B between fields C and D was 0.007.

The transformation from rectangular to equatorial coordinates was derived using stars from the list published by Magnier et al. (1992) for fields A–D, and the USNO-A2 catalog (Monet et al. 1996) for field F.

3. The catalog

In Figure 2 we plot the $V/V-I$ and $V/B-V$ color-magnitude diagrams (CMDs) from the combined A–D and F field catalogs. In the $V/V-I$ CMD (left panel), stars near $V \sim 22$ mag and $V-I \sim 1.8$ represent the top of the evolved red giant population. The vertical strip of stars with $0.6 < V-I < 1.2$ and $V < 20$ are Galactic foreground stars. Stars bluer than $V-I < 0.6$ are the upper main sequence stars in M31. In the $V/B-V$ CMD (right panel), the most prominent feature is the upper main sequence at $B-V \sim 0$. The Galactic foreground stars are also present, between 0.4 and 1.0 in $B-V$.

In Tables 1–5, we present the catalogs for fields A–D and F, with the equatorial coordinates and photometry in VI (fields A and B) and BVI (C, D, F). For each star we list its ID, α_{2000} , δ_{2000} equatorial coordinates, standard V , I and B magnitudes with their respective errors, and the Stetson variability index J_S (Stetson 1996). The IDs, based on the equatorial coordinates, are in the format D31Jhhmmss.s+ddmmss.s. The first three correspond to α , expressed in hours (hhmmss.s), the last three to δ in degrees (ddmmss.s).

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